

# Management of distal tibial medial malleolus type-6 physeal fractures

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## Abstract

**Purpose** Type 6 is an open fracture in which part of the physis is missing. It is the least common physeal fracture, but has the highest rate of complications, particularly the formation of a physeal bar. Without preemptive treatment, a physeal bar always forms, producing growth retardation and angular deformity, and excision of these physeal bars has been uniformly unsuccessful. The distal medial malleolus is a common site for the fracture.

**Methods** Strategies for the treatment of two varieties of acute medial malleolar type-6 fractures and two types of late deformities following type-6 fracture are given. The acute fractures were treated with either fat or cartilage applied to the exposed physis. The late deformities were treated with corrective iliac bone grafting.

**Results** The acute fractures were prevented from forming physeal bars and the two late deformities were fully corrected with good outcomes.

**Conclusion** Fat applied to an acute type-6 physeal fracture has a good chance of preventing bar formation. Ankle deformities due to bars can be corrected by means of iliac bone grafting.

**Keywords** Type-6 physeal fractures · Physeal bar · Loss of medial malleolus · Physeal fracture tibial medial malleolus

## Introduction

Type 6 is a fracture in which part of the physis is missing [1–3]. Usually, an accompanying part of the epiphysis or metaphysis, or both, is also missing. This is a result of an open fracture, caused by such things as a lawn mower, grain auger, motorboat propeller, motorized traffic accident, etc. It is the least common physeal fracture, but has the highest rate of complications, particularly the formation of a physeal bar [2, 3]. Without preemptive treatment, a physeal bar always forms—producing angular deformity and growth retardation—and their excision in these cases has been uniformly unsuccessful [2, 3]. The distal tibial medial malleolus is a common site for this fracture; we suggest strategies for the treatment of the distal tibial medial malleolus acute type-6 fracture and its otherwise inevitable physeal bar [3].

## Part A. Acute care for loss of a superficial portion of the medial malleolus: talar stability maintained

When there is loss of the superficial portion of the medial malleolus (Fig. 1a), the physis is exposed, predisposing it to premature arrest. Ankle joint integrity and stability are maintained. In this instance, application of fat against the physis at the time of initial repair (Fig. 1a') may prevent bar formation temporarily or indefinitely. The fat could be on a flap transfer [4] (free or pedicle) or free fat (vascularized or nonvascularized), depending on the nature of the wound. In a thin person, there may be a paucity of fat within the injured area. In this instance, fat may be taken from a small incision in the buttock crease. This strategy was successful in maintaining growth without bar formation in one case performed immediately and unsuccessful in another performed 10 months post-injury [4].

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### Part B. Acute care of loss of the entire medial malleolus: talar stability questionable

Loss of the entire medial malleolus (Fig. 1b) predisposes the exposed physis to premature arrest and the talus to instability. In such a case, reconstruction of the medial malleolus with the goal of maintaining growth may be attempted by substituting the missing physis with iliac apophyseal cartilage (Fig. 1b'). A block of iliac crest bone is divided obliquely and the apophyseal cartilage is placed adjacent to the physis. The second piece, without cartilage, is used to reconstruct the missing medial malleolus. Both parts of the iliac crest block are attached with their cancellous surfaces facing the tibia with screws. The bone graft is covered with free soft tissue graft. One successful case performed 12 days post-injury has been reported [5].

Utilization of the strategies presented in Fig. 1a' and b' will depend on the nature and severity of the bone and soft tissue loss. Ideally, there would need to be immediate soft tissue coverage without concern for infection.

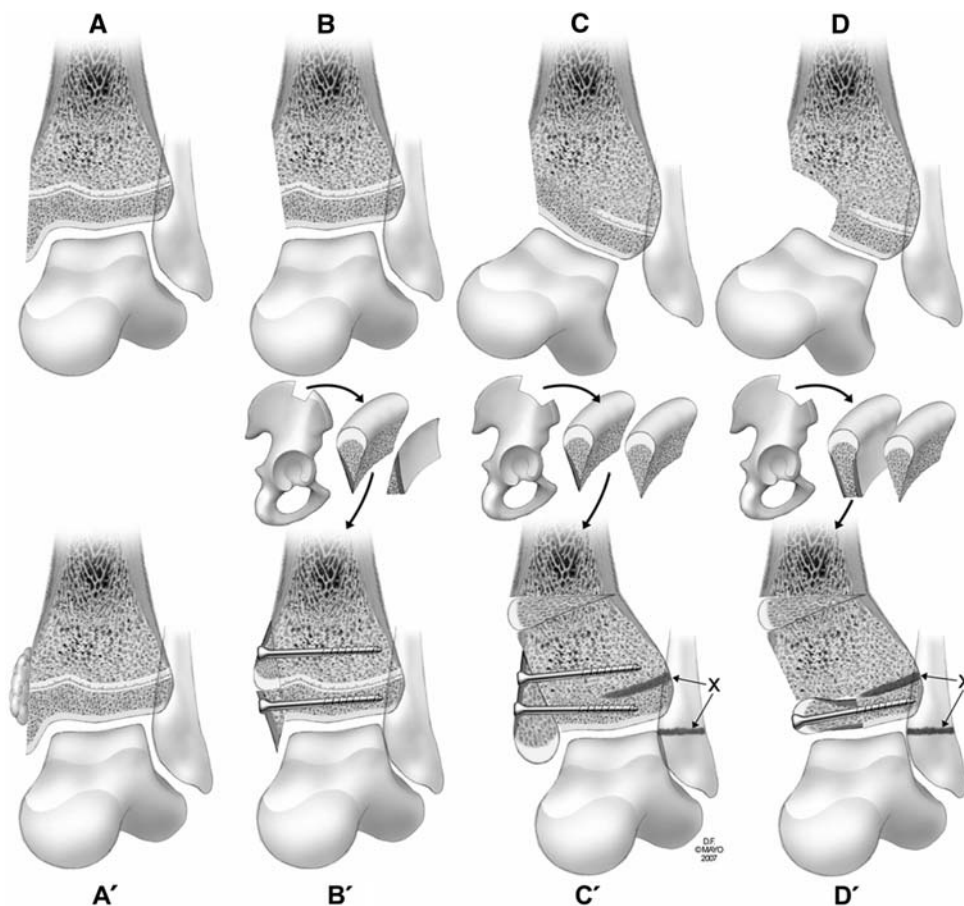
### Part C. Late care of absence of the medial malleolus with medial physal bar

Complete absence of the medial malleolus resulting in a medial physal bar causes varus angulation (Fig. 1c) and predisposes to talar instability and degenerative arthrosis. This can be treated by inserting a piece of iliac crest longitudinally, using the apophysis for the tip of the malleolus, combined with closure of the physes of the distal fibula and lateral tibia, and corrective tibial osteotomy when appropriate (Figs. 1c', 2)

### Part D. Late care of absence of the medial malleolus plus part of the distal medial epiphysis

Loss of the medial malleolus plus part of the medial epiphysis resulting in a medial physal bar causes varus angulation (Fig. 1d), predisposes to talar instability, and ensures rapid degenerative arthrosis. It can be managed by inserting iliac crest block graft transversely into the defect (Fig. 1d'), combined with arrest of the distal fibular and

**Fig. 1** Loss of medial malleolus. **a** Partial. **b** Complete. **c** Complete with physal bar formation. **d** Complete with additional loss of epiphysis and bar formation. **a'** Fat transfer, free or flap. **b'** Divided iliac crest apophyseal cartilage transfer. **c'** Whole iliac crest transferred longitudinally. **d'** Whole iliac crest transferred transversely. **x** Surgical physal arrest (**b'** is redrawn from Mayr et al. [5], **c'** and **d'** are redrawn in part from Scheffer and Peterson [6])





**Fig. 2** An 11-year and 9-month-old boy was struck and dragged by a car, sustaining a distal tibial medial malleolar type-6 physeal fracture with extensive soft tissue loss. The anterior medial part of the distal tibia (the entire medial malleolus) was missing. Treatment consisted of debridement and free flap soft tissue graft. **a** The soft tissues had healed 8 months post-injury (age 12 years and 5 months). The talus could be subluxated medially. A medial physeal bar resulted in gradual ankle varus and medial ankle subluxation. Medial soft tissue release and open-wedge osteotomy [6] of the distal tibia using iliac

crest bone were combined with physeal arrest of the ipsilateral distal fibula and contralateral distal tibia and fibula 1 month later. **b** At age 13 years and 0 months, iliac crest cartilage was used as a buttress to rebuild the medial malleolus (Fig. 1c') internally fixed with two screws. **c** At the last follow-up, 8 years 10 months post-injury (age 20 years and 7 months), the ankle joint was perpendicular to the tibial shaft and reasonably congruent. **d** The patient ambulates without pain or limp. **e** There is 10° dorsiflexion and 40° plantar flexion

lateral tibial physes and corrective tibial osteotomy (Fig. 3). The concave contour on the inner side of the iliac crest is nearly congruent with the sagittal convexity of the dome of the talus.

### Osteotomy and graft preparation

In cases with substantial medial malleolar defects and physeal bars, as noted in Figs. 1c, d, 2, and 3, staging of the osteotomy for angular correction and of the malleolar reconstruction will depend on the degree of the deformity and the particulars of the soft tissue coverage. Open-wedge osteotomy using a wedge of iliac crest bone [6] corrects the deformity, adds a little length and, if done concurrently with repair of the malleolus, the same iliac donor site can be used

for both grafts (Figs. 1c', d', 3). Preparation of the iliac crest graft defects, depicted in Fig. 1b', c', and d', requires contouring by means of an osteotome or a motorized bur, excoriating or removing cortical bone, so that the graft fits the defect snugly and cancellous bone opposes the recipient bone. Any remaining cortical bone opposing the recipient bone may be punctured multiple times with a small drill bit to enhance blood flow into the graft to facilitate bone union.

### Prognosis

All patients with type-6 fracture of the medial malleolus, regardless of initial outcome, are prone to develop degenerative arthrosis and should be cautioned against excessive weight gain and activities detrimental to the ankle.

**Fig. 3** A 9-year 9-month-old boy sustained a distal tibial type-6 physeal fracture and extensive soft tissue loss of the left ankle in a farm auger injury.

**a** The medial malleolus and some of the distal tibial epiphysis were missing. The wound was debrided multiple times and covered with split thickness skin grafts on the 16th post-injury day. **b** A physeal bar was obvious 6 months post-fracture (age 10 years and 3 months). Surgical physeal arrest of the left distal fibula and lateral tibia, and of the normal right distal tibia and fibula was performed at age 10 years and 4 months. **c** At 13 months post-injury, age 10 years and 10 months, left ankle varus was 27°. **d** At age 11 years 0 months, open-wedge osteotomy [6] was combined with reconstruction of the medial malleolus using iliac crest bone placed transversely. The concavity of the inner surface of the iliac crest approximated that of the convex dome of the talus. **e** At age 16 years and 10 months, 7 years and 1 month post-injury, there was full range of motion and no limp. He was active in high school soccer and basketball and had mild intermittent ankle swelling and aching with weather change. (Reproduced in part from Peterson [3], with permission)



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